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Comparative Study of Special Concrete with Conventional Concrete for Bridges and Precast Structures

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Abstract – *India is a progressing country and there is immense development in construction field. Transportation sector plays vital role in socio-economic development of country. One of the most emerging constructions in transportation sector in India is bridges and elevated viaducts construction. The main objective of this paper is to grant more durability, strength, economy and sustainability to bridge and precast concrete structure. This paper discusses the comparative study of normal concrete and special concrete and determines the suitability of concrete for bridges and other precast units. Special concrete is addition of special ingredients (micro silica, poly-propylene fiber and bacillus subtilis) to conventional concrete ingredients. These special ingredients enhance the various engineering properties of concrete and fulfill the strength and durability parameters of bridges. The effect of compressive strength, water permeability and tensile strength of concrete cubes after mixing all these special ingredients is also discussed in this paper. Different cube specimen of special and conventional concrete were tested for various test and it was found that special ingredient concrete works significantly better in improving the characteristics properties of concrete as compared with conventional normal concrete.*

Key Words: **Concrete, Strength, Durability, Cracks, Bridge.**

1. INTRODUCTION

In transportation system of any country bridges and elevated viaducts are the key elements of importance for smooth functioning of traffic. The most preferred method in superstructure in concrete bridge is precast method. Precast girder bridges require high grade high strength special concrete. Bridges tolerate heavy loads throughout the lifespan of structure and it should be constructed with concrete having higher compressive strength and durability. Nowadays, there is growing demand of concrete for pre-stressed concrete for bridges and elevated viaducts which requires high strength concrete. Hence the concrete used for construction of such bridges should be engineered with improved strength and durability. The addition of special ingredients in conventional concrete enhances the engineering properties of concrete. Special concrete almost always have relative more strength and durability as compared to conventional concrete. Cracks are unavoidable in concrete structure and it reduces the durability and lifespan of concrete. This paper discusses the formulation of special type of concrete by using special ingredients such as micro silica, poly-propylene fiber, and bacillus subtilis (Bacteria). The comparative effect of water permeability test, compressive strength test, and tensile strength test of cement concrete cubes of both special and conventional concrete are discussed in this paper. It was found that bacillus subtilis seals the cracks forms in concrete and improve the stiffness of structure, micro silica increases the compressive strength of concrete and poly-propylene fiber enhance the integrity of concrete structure.

2. OBJECTIVES

1) To Study the properties and effects of special ingredients in concrete.

2) To Carry out the Comparative study between Special and normal Conventional Concrete.

3) To determine the optimum proportion of Special ingredients and formulate the Special Concrete.

4) To enhance the Strength, Durability and Serviceability of Bridges and precast Structures.

3. MATERIAL AND METHODS

3.1 Special Concrete

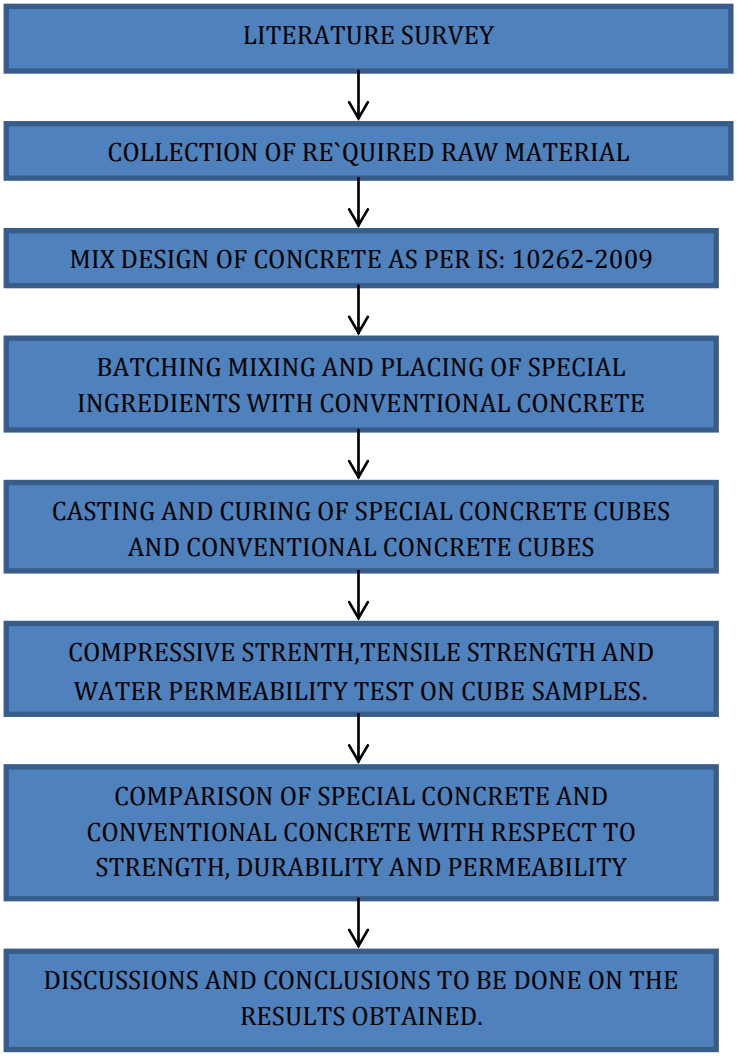
Special concrete are the concrete designed for special role or function to boost increased strength and durability for bridges. The term special concrete is nothing but conventional concrete along with combination of special ingredients. These special ingredients added in normal concrete to boost the required engineering properties which ultimately increases the strength and durability of bridge structure. Special concrete provides more compressive strength, more durability and more integral stiffness of concrete structure as compared to conventional one. Special concrete are designed to fulfils the every aspect of strength and other criteria required for bridge and other precast structure.

Special concrete are made up of cement, sand, aggregate, water, bacillus subtilis, micro silica, polypropylene fiber.

MATERIAL	PROPERTIES
Cement	• OPC – 53 Grade (IS:12269-1987)
Fine Aggregate	• River sand passing through 4.75mm IS sieve (IS:383-1987). • Specific gravity of sand - 2.31
Coarse aggregate	• Crushed stone of max. size 20mm and retained on 4.75mm. • Specific gravity of aggregate – 3.13
Water	• Potable water free from silt, salt, oil and greases.
Bacillus Subtilis	• Microorganism bacteria from variety bacillus species 'Bacillus subtilis' is bar molded structure an intense defensive end spores permitting it to endure outrages environmental condition. • It can acclimate to antacid (alkaline) state of concrete for creation of calcium carbonate. • Crystallization of calcium carbonate minerals heals the pores and crack in concrete.
Polypropylene fiber	• Fibers improve rigidity, flexural quality and durability of concrete by means of improving post-cracking, ductility, and control cracking. • For fiber reinforced concrete several fiber materials in various shape and sizes have been developed. • Among these fibers the polypropylene fibers has been most successful commercial application in concrete. • Unique properties of polypropylene fiber make them suitable for reinforcement in concrete.
Micro silica	• Silica rage is an exceptionally fine non-crystalline sio2, is a result of Ferro-silicon industry. • It is made at temperature of around 2000 deg.C and its molecule size is very finer than cement. Hence, can be acts as an excellent pore filling material. • It can be utilized in various extent ranging from 5% to 10% in concrete as a solid blend. • Micro silica emerges as one of the best material to blend with concrete to improves the compressive strength of concrete.

4. METHODOLOGY

In this experimental analysis, we have designed two sample of M30 grade of concrete as per IS:10262-2009. In which first sample was conventional concrete of M30 grade and second sample was prepared by adding special ingredients along with conventional concrete to formulate special concrete. Special ingredients were batched, mixed, placed, compacted and cured along with conventional concrete. Casting of cube specimen of both sample were taken and after 28 days curing period, samples were proceed for testing. Various tests were carried out on cube samples and comparative result of both samples determines the suitability of concrete for bridge structure.



5. EXPERIMENTAL PROCEDURE

PROCEDURE	PROPERTIES
1. Mix design	• Concrete mix design of grade M30 as per IS:10262-2009.
2. Test on cement	• Normal consistency test • Initial and final setting time test • Specific gravity test • Fineness test
3. Test on aggregate	• Water absorption test • Sieve analysis test • Water content test • Specific gravity test
4. Addition of special concrete	• Special ingredients (bacillus subtilis, poly-propylene fiber, microsilica) were batched, mixed and placed in conventional concrete.

5. Slump test	• Slump cone test is carried out of freshly prepared concrete to determine the workability of concrete.
6. Cube casting	• Concrete cubes specimen of special and normal concrete were casted separately as per mix design.
7. Curing	• 28 days water curing were carried out of cube specimen.
8. Compression test	• Compressive strength is measure of each cube specimen after completion of curing period by compression testing machine.
9. Tensile test	• Tensile strength were measured of both sample by testing the cylindrical concrete specimen of diameter 150mm and length 300mm.
10. Water permeability test	• Water permeability test measures the depth of water penetrated under pressure.
11. Results comparison	• Test results of special concrete specimen were compared with conventional concrete to evaluate the suitability of concrete.

6. RESULTS

6.1 Compressive strength test

Table-1: Compressive strength test

DESCRIPTION	SAMPLE - A	SAMPLE - B
BACILLUS SUBTILIS (%)	0	5
MICRO SILICA (%)	0	10
PP FIBER (%)	0	1
COMPRESSIVE STRENGTH (N/mm²)	32.23	38.76
REMARKS	Conventional concrete	Special concrete

6.2 Tensile strength test

Table-2: Tensile strength test

DESCRIPTION	SAMPLE - A	SAMPLE - B
BACILLUS SUBTILIS (%)	0	5
MICRO SILICA (%)	0	10
PP FIBER (%)	0	1
Tensile STRENGTH (N/mm²)	3.42	4.38
REMARKS	Conventional concrete	Special concrete

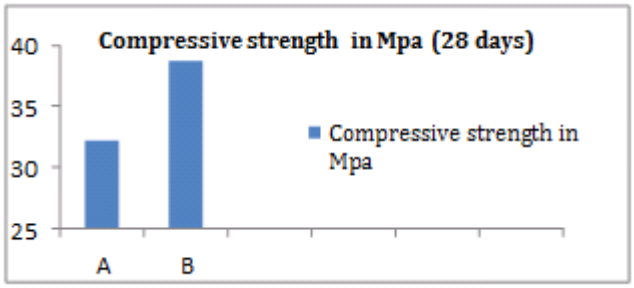
6.3 Water Permeability test

Table-3: Water Permeability test

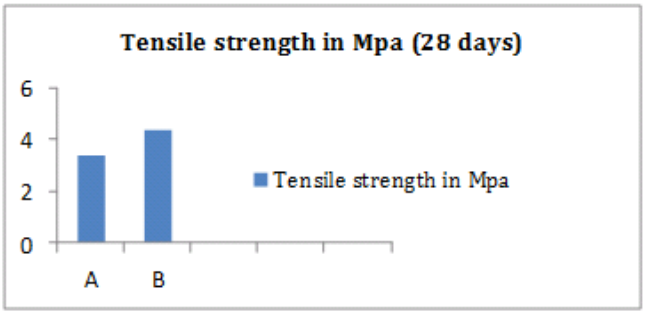
DESCRIPTION	SAMPLE - A	SAMPLE - B
BACILLUS SUBTILIS (%)	0	5
MICRO SILICA (%)	0	10
PP FIBER (%)	0	1
WATER PENETRATION DEPTH (mm)	4.4	2.9
REMARKS	Conventional concrete	Special concrete

7. GRAPHICAL REPRESENTATION

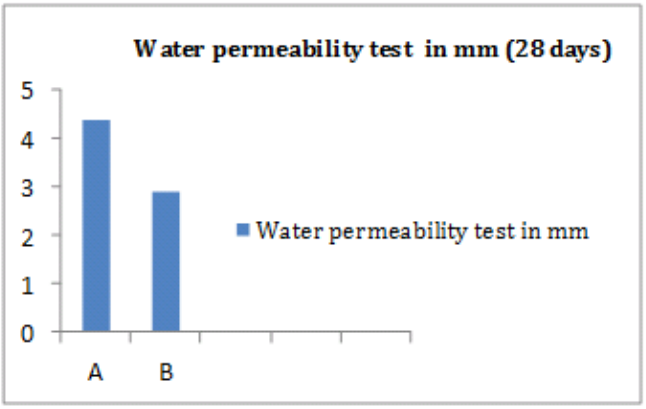
7.1 Compressive strength test



7.2 Tensile strength test



7.2 Water Permeability Test



8. DISCUSSION

In this study the engineering properties of conventional concrete were enhanced by adding special ingredients which ultimately boost the strength, durability and integrity of concrete structure. The main objective of this project was to formulate special type of concrete for bridge and precast structure and compare the results of this special concrete with conventional concrete. When different cube specimen of special and conventional concrete were tested for compressive strength test, it shows the compressive strength of special concrete increases significantly as compared to normal concrete of same grade. Results of tensile strength test and water permeability test was also

found far better in special concrete as compared to conventional one. Special ingredients used in special concrete having much higher cost than the normal conventional concrete ingredients and thus increases the initial cost of structure.

9. CONCLUSION

Introducing the special ingredients within the normal concrete perform it extremely useful in improving the compressive strength and structural durability of concrete. From the experimental study it can be concluded that the specials ingredients works significantly in enhancing the characteristics properties of concrete which are suitable for heavy structures like bridge and precast unit.

It was found that addition of combination of these ingredients increases the compressive strength by 20%, increases tensile strength by 28% and decreases water permeability by 34% as compared with conventional concrete of M30 grade. From complete comparative study it can be said that the special concrete found feasible for heavy bridge and precast concrete structure.

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